(12) UK Patent Application (19) GB (11) 2 198 060 (13) A

(43) Application published 8 Jun 1988

(21) Application No 8724831

(22) Date of filing 23 Oct 1987

(30) Priority data
(31) 2882/86 (32) 30 Oct 1986 (33) AT

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(51) INT CL⁴
B02C 19/00

(52) Domestic classification (Edition J):
B2A 7H 7R9 7RX
U1S 1264 B2A

(56) Documents cited
None

(58) Field of search
B2A
Selected US specifications from IPC sub-class B02C

(54) An impact mill for crushing hard material

(57) An impact mill for crushing hard material such as stone has a substantially annular housing and a rotor (2) with an axial intake opening for material to be crushed. The rotor (2) has a bottom plate with a central impact plate member (7), a cover plate with a central aperture and blades (11) which form ejection openings (16) between the bottom and cover plates and which are each provided with a respective pocket (17) for receiving crushed material. The ejection side of each pocket (17) has a wear member which is replaceably secured to the blade (11) and which is formed by a carrier body portion (12) and a hard metal bar portion (13). The ejection-side inner surface of the pocket (17) is a surface (20) of the hard metal bar portion (13) and extends substantially perpendicularly to a contact plane (B) of the marginal edges of the pocket (17). The hard metal bar portion (13) has an arcuate wear surface (21) and projects with its outside edge beyond the periphery of the rotor (2). The inner surface of the carrier body (12) and the inward surface (20) of the hard metal bar portion (13) together form an angle in the range of from 95° to 110° and extends symmetrically with respect to a radius of the rotor (2).

Fig.2

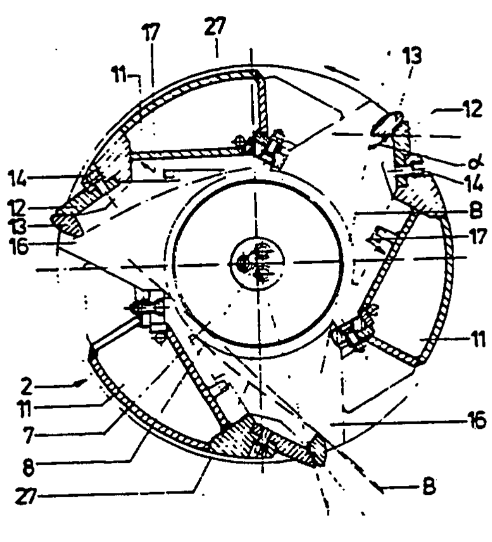
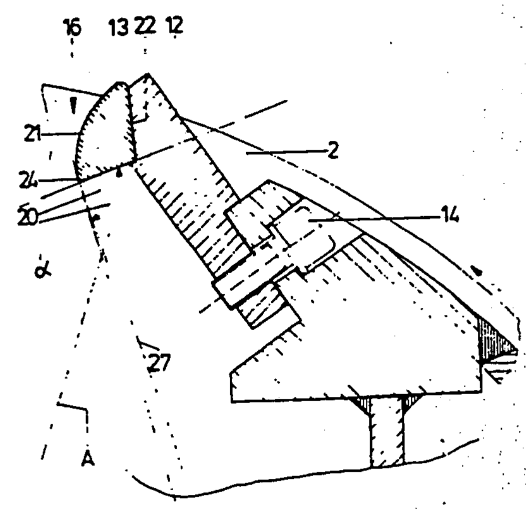


Fig 3



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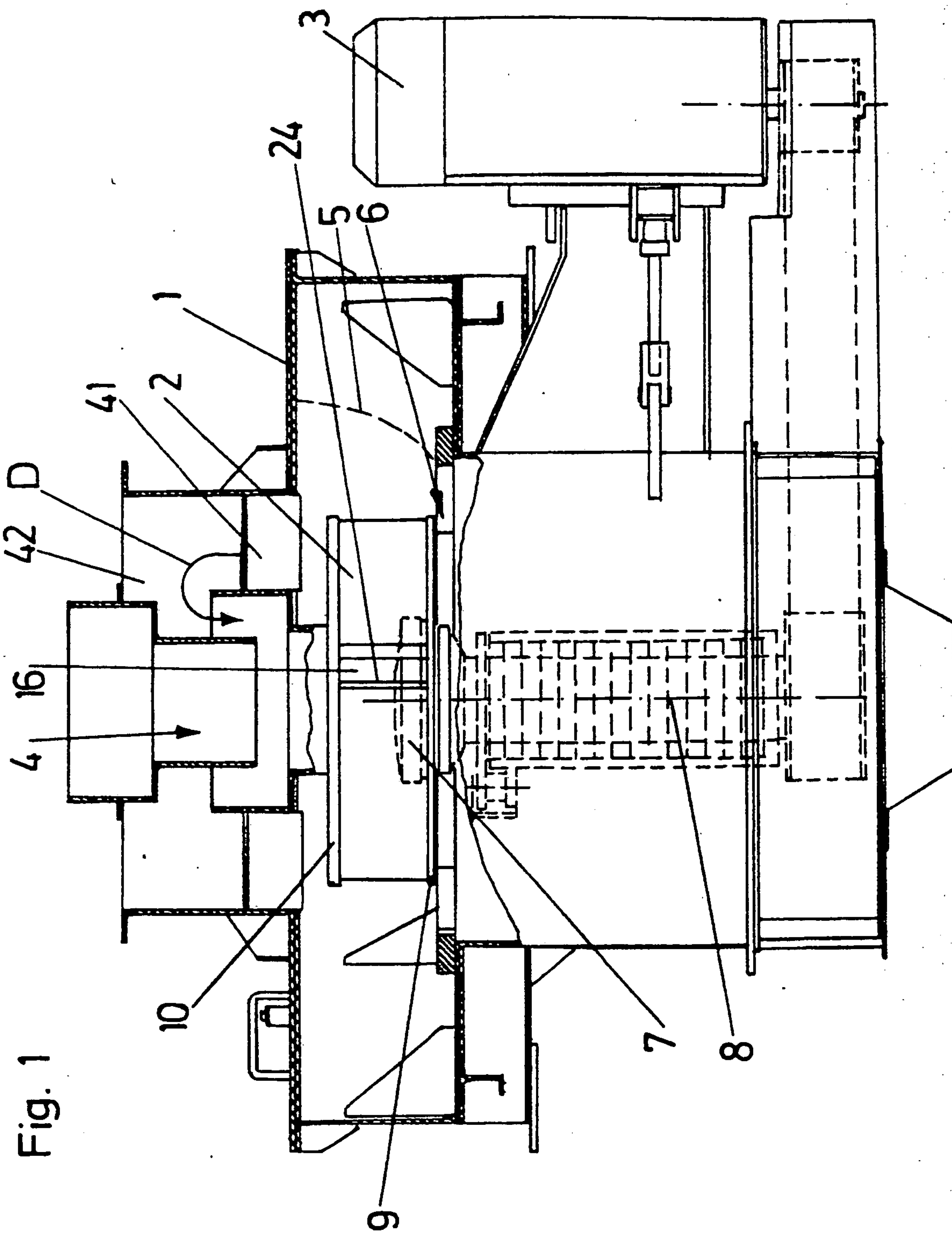


Fig. 1

Fig. 2

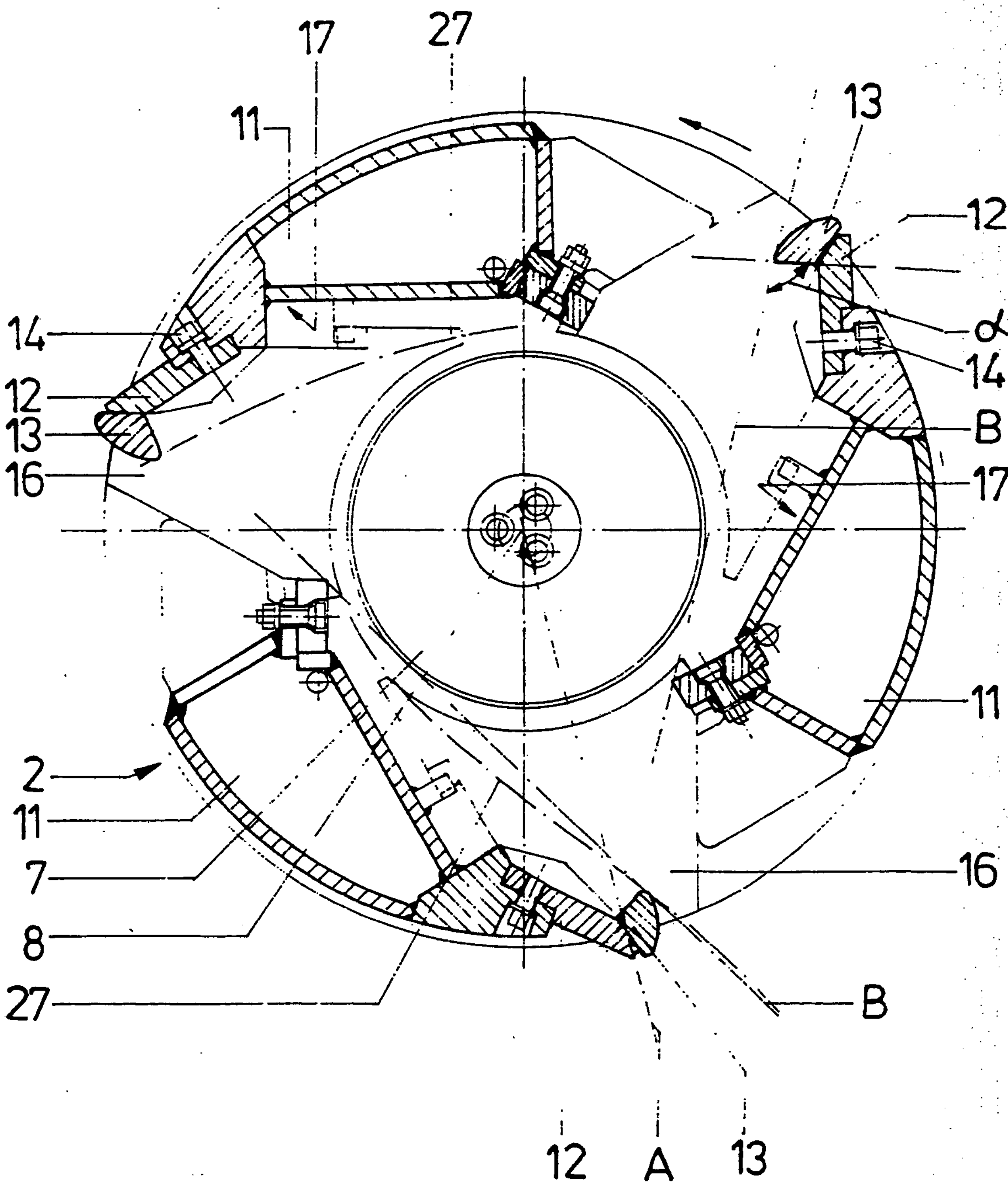
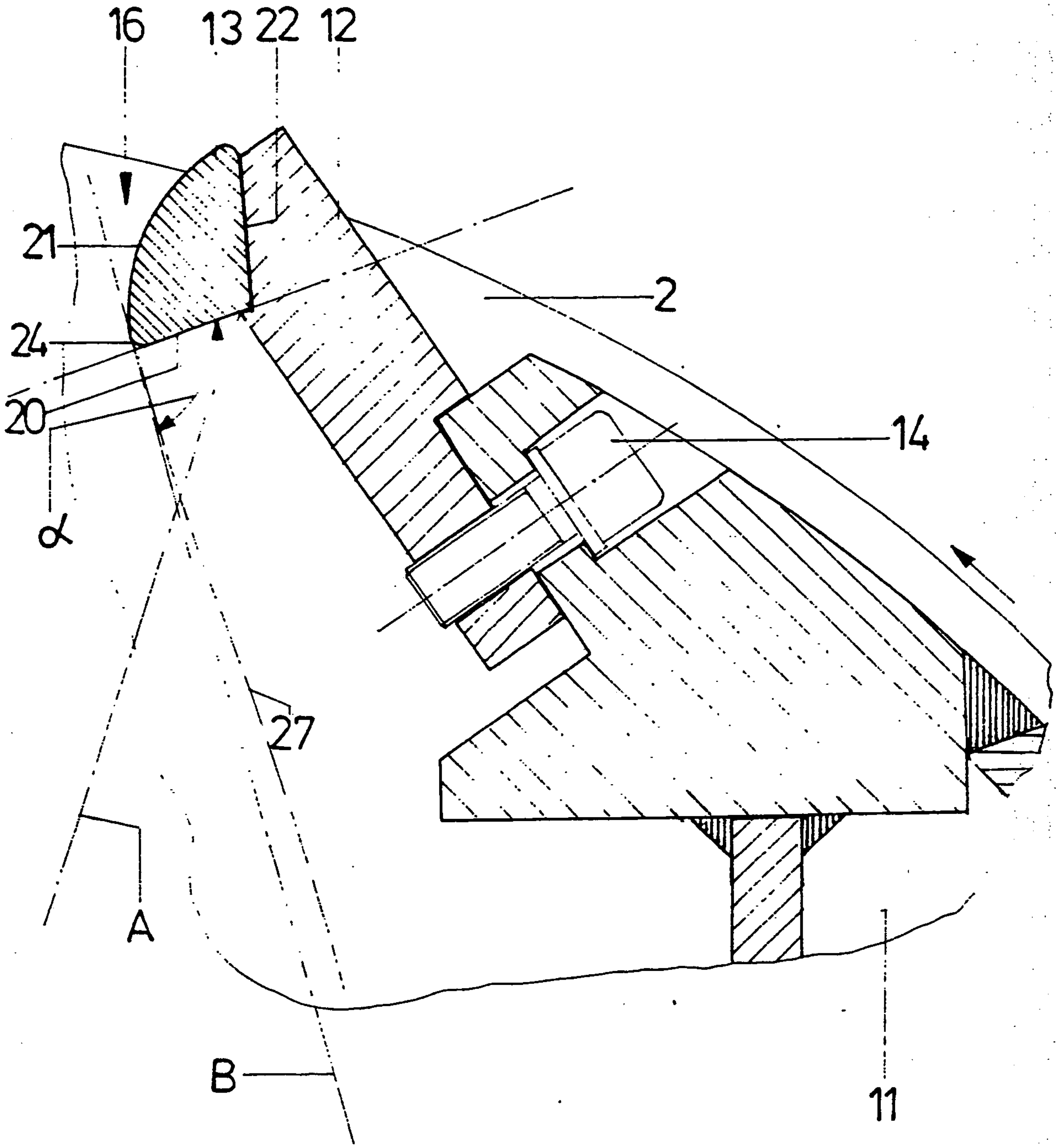


Fig. 3



AN IMPACT MILL FOR CRUSHING HARD MATERIAL

This invention relates to an impact mill for crushing hard material such as stone. Such a mill includes a substantially annular housing, a rotor with an axial intake opening for material to be crushed, which rotor is rotatably mounted in the housing to rotate about a substantially vertical axis, forms an annular gap between the rotor periphery and the housing and has a bottom plate with a central impact plate member, a cover plate with a central aperture for receiving material to be crushed and blades forming ejection openings between the bottom and cover plates. The sides of the blades which face towards the axis of the rotor each have a pocket for receiving crushed material. The ejection side of the pocket has a replaceable wear member formed by a carrier body portion and a hard metal or metal carbide bar portion as marginal edge reinforcement. This bar portion forms a wear surface which is set back in the ejection direction and whose surface bounding part the material-receiving pocket extends an angle to a contact plane of the marginal edges of the material-receiving pocket and whose outer edge projects beyond the periphery of the rotor.

European laid-open application No.187252 discloses an impact mill of this kind. In the disclosed mill the hard or carbide metal reinforcement is of a substantially L-shaped form which extends radially outwardly from the ejection-side edge of the material-receiving pocket and which forms an angle of between 180° and 195° with the contact plane, in a first operative surface portion. A second operative surface portion adjoins the first in set-back relationship in an outward direction, and projects beyond the periphery of the rotor.

It has now been found that the service life of the entire wear member is less than was expected as the ejection-side inside surface of the material-receiving pockets, which is mainly formed by the carrier body portion, is exposed to surprisingly high grinding loads and is therefore eroded more rapidly than the exposed hard metal bar portion.

There is thus a need for a generally improved impact mill for crushing hard material such as stone, in which, as far as possible the service life thereof is determined only by the service life of the hard metal bar portion.

According to the present invention there is provided an impact mill for crushing hard material such as stone, including a substantially annular housing, a rotor with an axial intake opening for material to be crushed, which rotor is rotatably mounted in the housing to rotate about a substantially vertical axis, forms an annular gap between the rotor periphery and the housing and has a bottom plate with a central impact plate member, a cover plate with a central aperture for receiving material to be crushed and blades forming ejection openings between the bottom and cover plates, with sides of the blades which face towards the axis of the rotor each having a pocket for receiving crushed material, wherein the ejection side of the pocket has a replaceable wear member formed by a carrier body portion and a hard metal or metal carbide bar portion as marginal edge reinforcement, which bar portion forms a wear surface which is set back in the ejection direction and whose surface bounding part of the material-receiving pocket extends at an angle to a contact plane (B) of the marginal edges of the material-receiving pocket and whose outer edge projects beyond the periphery of the rotor, wherein the surface of the bar portion bounding part of the material-receiving pocket forms the inner surface of the material-receiving pocket and extends substantially perpendicularly to the contact plane (B) of the marginal edges of the material-receiving pocket and wherein the set-back wear surface of the bar portion is convexly arcuately curved.

As tests have shown, the shape and position of the wear member in the mill of the invention also reinforces the ejection-side inside surface of the material-receiving pocket so that the grinding action of the material being crushed also wears away the hard metal bar portion at the surface which is disposed transversely to the ejection direction. Therefore wear of the hard metal bar portion occurs not only at the wear surface which is set back from the contact plane, but the inward surface is also worn away to the same extent. The hard metal bar portions are thus worn away completely, whereas the carrier body portion which is disposed at the bottom of the material-receiving pocket is subjected to lower load, thereby considerably enhancing service life.

The expression substantially perpendicular to the contact plane (B) as used herein means a deviation from the perpendicular of up to 15°, i.e. in the range of from 75° to 105°, as the aim is to produce a substantially perpendicular configuration relative to the portion, adjacent to the marginal

edge, of the curved surface of the crushed material which builds up in the material-receiving pocket. This curved surface is dependent in size and shape on the material being crushed and the speed of rotation of the rotor and follows a spiral line. For the usual situations of use, an angle in the range of from about 95° to 100° has been found to be a satisfactory average value.

The set back arcuately curved wear surface extends for a quarter of a circle. In this way the arc substantially corresponds to the line of ejection of the crushed material so that the wear surface is worn away in a fairly uniform manner. The edges between the set back wear surface and the mounting surface which bears against the carrier body portion or the inner surface of the bar portion, on the pocket side thereof, preferably are rounded.

The carrier body portion which is used to support the bar portion, is preferably made of steel, and preferably is substantially plate-shaped in form with a bevelled contact surface for the bar portion. The entire wear member is substantially L-shaped which has been found to be advantageous for the two surfaces on the pocket side, that is to say the inside surfaces of bar portion and the surface of the carrier body portion which forms the bottom of the pocket, to extend substantially symmetrically with respect to a radius of the rotor. The symmetry angle is preferably in the range of 15 from 50° to 55°.

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a vertical sectional view through an impact mill according to a first embodiment of the invention.

Figure 2 is a horizontal sectional view through a rotor of Figure 1, and

Figure 3 is a view to an enlarged scale in detail of one end of a rotor blade of Figures 1 and 2, fitted with a wear member.

An impact mill according to the invention for stone crushing has a substantially annular housing 1 mounted on a substructure containing drive means and a discharge opening for crushed material. The housing 1 has a substantially U-shaped configuration in cross-section, with the open mouth facing radially inwardly. Material being crushed, which is deposited around

the housing interior during operation of the mill forms impact surfaces therein. A rotor 2 which is driven by a motor 3 of the drive means is mounted for rotation about a vertical axis 8 in the housing 1, an annular gap 6 remaining between the rotor 2 and the housing 1, through which crushed material drops downwardly to the discharge opening. The rotor 2 has a bottom plate 9, a cover plate 10 and blades 11 arranged therebetween. The cover plate 10 has a central opening through which the material to be crushed, which is delivered via a filling opening 4, passes into the interior of the rotor 2. Beneath the opening in the cover plate 10 is an impact plate or disc member 7 which distributes the material to be crushed which is accelerated in the rotor 2 by the blades 11 and which is finally flung by centrifugal force through discharge openings 16 at the rotor periphery against the impact surfaces of the housing 1 and thus broken up. The peripheral speed of the rotor is preferably in the range of from 60 to 72 m/s (metres per second). Although the rotor 2 naturally causes strong air movement, the production of dust is avoided by the air passing out of the rotor 2 being passed via baffle plates 41 into a direction-changing passage 42 from which it is returned to the opening in the cover plate 10 (arrow D in Figure 1). This gives rise to an internal circulation of air so that there is no external production of dust.

As can be seen from Figure 2, the rotor 2 is provided with three blades 11 which extend substantially in the direction of the periphery of the rotor, leaving free a middle region of the same size as the impact plate or disc member 7. Each blade 11 is made up of a three-sided member with an outer side which is curved to correspond to the periphery of the rotor, and inner sides such that inner sides of an adjacent pair of blades 11 define an ejection passage there between which decreases in size towards the peripheral discharge opening 16. One of the two inner sides of each three-sided member extends in a generally concave manner, thereby forming a pocket 17 in which material being crushed accumulates at the beginning of the crushing operation. The surface of the accumulated material thus forms an impact surface helping to protect the blade 11 from damage. A contact plane B which contacts the two marginal edges of the material-receiving pocket 17 in which the rotary movement of the rotor causes the formation of a surface of material which follows a curved line 27 preferably extends substantially tangentially relative to the impact plate or disc member 7 and, with an axial plane A or a radius of the rotor (Figure 3),

includes an angle of preferably 35°. Arranged at the ejection end of the blade 11, at which point surface protection by means of an accumulation of crushed material is no longer possible, is a replaceable wear member which projects beyond the periphery of the rotor and which is formed by a steel carrier portion 12 which is secured to the blade 11, and a low-wear hard metal or metal carbide bar portion 13, in particular of type B 10 T carbide with a tungsten carbide component of 94%, a Vickers hardness of 1450 HV (Hardness Vickers) and a tungsten carbide grain size in the range of from 0.002 to 0.004 mm. (millimetres). Preferably the bar portion 13 is made from an alloy with a tungsten carbide content greater than 91% with the balance, apart from impurities and incidental constituents, being cobalt. The parts of the wear member which project beyond the periphery of the rotor 2 protect the peripheral parts of the blades 11 so that any armouring which is to be provided at that location can be thinner.

Figure 3 shows a detail of the end of a blade 11, which is fitted with the wear member. The carrier body portion 12 which is secured to the end of the blade 11 by screws 14 is, for example, of the illustrated, substantially plate-like form. In cross section the bar portion 13 is part of a circular surface and has an outer, convex arcuate wear surface 21, an inner surfce 20 which forms an inside surface of the material-receiving pocket 17, and a mounting face 22 attached to a bevelled support surface on the carrier body portion 12. The bar portion 13 may also be divided along its height into a plurality of portions.

The hard metal bar portion 13 is secured to the end of the carrier body portion 12, being in particular brazed thereto, in such a way that the tangent to the wear surface 21 and its separation or discharge edge 24 lies approximately in the contact plane B and the inner surface 20 extends at an angle (α) in the range of from 75 to 105°, preferably in the range of from 90 to 105°, and more preferably 95°, to the plane B. The width of the inner surface 20 is approximately two thirds of the radius of curvature of the wear surface 21. The width of the mounting face 22 approximately corresponds to the length of the radius of curvature and the mounting face 22 and the inner surface 20 include an angle therebetween in the range of from 100° to 115°, preferably of 105°. The wear member is therefore generally of an L-shaped configuration, with the shorter limb being formed

by the hard metal bar portion 13 and with the longer limb being formed by the carrier body portion 12, and the two include an angle preferably in the range from 95° to 110°, more preferably 105°. The overall arrangement of the wear portion is preferably such that the mitre plan of the wear portion lies in the axial plane A. Preferably the arcuate wear surface 21 extends for a quarter of a circle.

CLAIMS

1. An impact mill for crushing hard material such as stone, including a substantially annular housing, a rotor with an axial intake opening for material to be crushed, which rotor is rotatably mounted in the housing to rotate about a substantially vertical axis, forms an annular gap between the rotor periphery and the housing and has a bottom plate with a central impact plate member, a cover plate with a central aperture for receiving material to be crushed and blades forming ejection openings between the bottom and cover plates, with sides of the blades which face towards the axis of the rotor each having a pocket for receiving crushed material, wherein the ejection side of the pocket has a replaceable wear member formed by a carrier body portion and a hard metal or metal carbide bar portion as marginal edge reinforcement, which bar portion forms a wear surface which is set back in the ejection direction and whose surface bounding part of the material-receiving pocket extends at an angle to a contact plane (B) of the marginal edges of the material-receiving pocket and whose outer edge projects beyond the periphery of the rotor, wherein the surface of the bar portion bounding part of the material-receiving pocket forms the inner surface of the material-receiving pocket and extends substantially perpendicularly to the contact plane (B) of the marginal edges of the material-receiving pocket and wherein the set-back wear surface of the bar portion is convexly arcuately curved.

2. An impact mill according to claim 1, wherein the bar portion is made of an alloy with a tungsten carbide content greater than 91% with the balance, apart from impurities and incidental constituents, being cobalt.

3. An impact mill according to claim 1 or claim 2, wherein the surface of the bar portion forming the inner surface of the material-receiving pocket extends at angle (α) to the contact plane (B) in the range of from 75 to 105°.

4. An impact mill according to anyone of claims 1 to 3, wherein the set-back arcuately curved wear surface extends for a quarter of a circle.

5. An impact mill according to anyone of claims 1 to 4, wherein the

inner surface of the bar portion, which lies in the material receiving pocket, extends at an angle (α) of about 95° to the contact plane (B).

6. An impact mill according to anyone of claims 1 to 5, wherein the bar portion is attached to the carrier body portion at a mounting surface which extends at an angle of 105° to the inner surface of the material-receiving pocket.

7. An impact mill according to claim 6, wherein the edge between the set back wear surface and the mounting surface is rounded.

8. An impact mill according to anyone of claims 1 to 7, wherein the carrier body portion is substantially plate-shaped in form and has a bevelled support surface for the mounting surface of the bar portion.

9. An impact material for crushing hard material such as stone, substantially as hereinbefore described and as illustrated in the accompanying drawings.